THE PARENT STELLAR POPULATIONS OF NEARBY SUPERNOVAE

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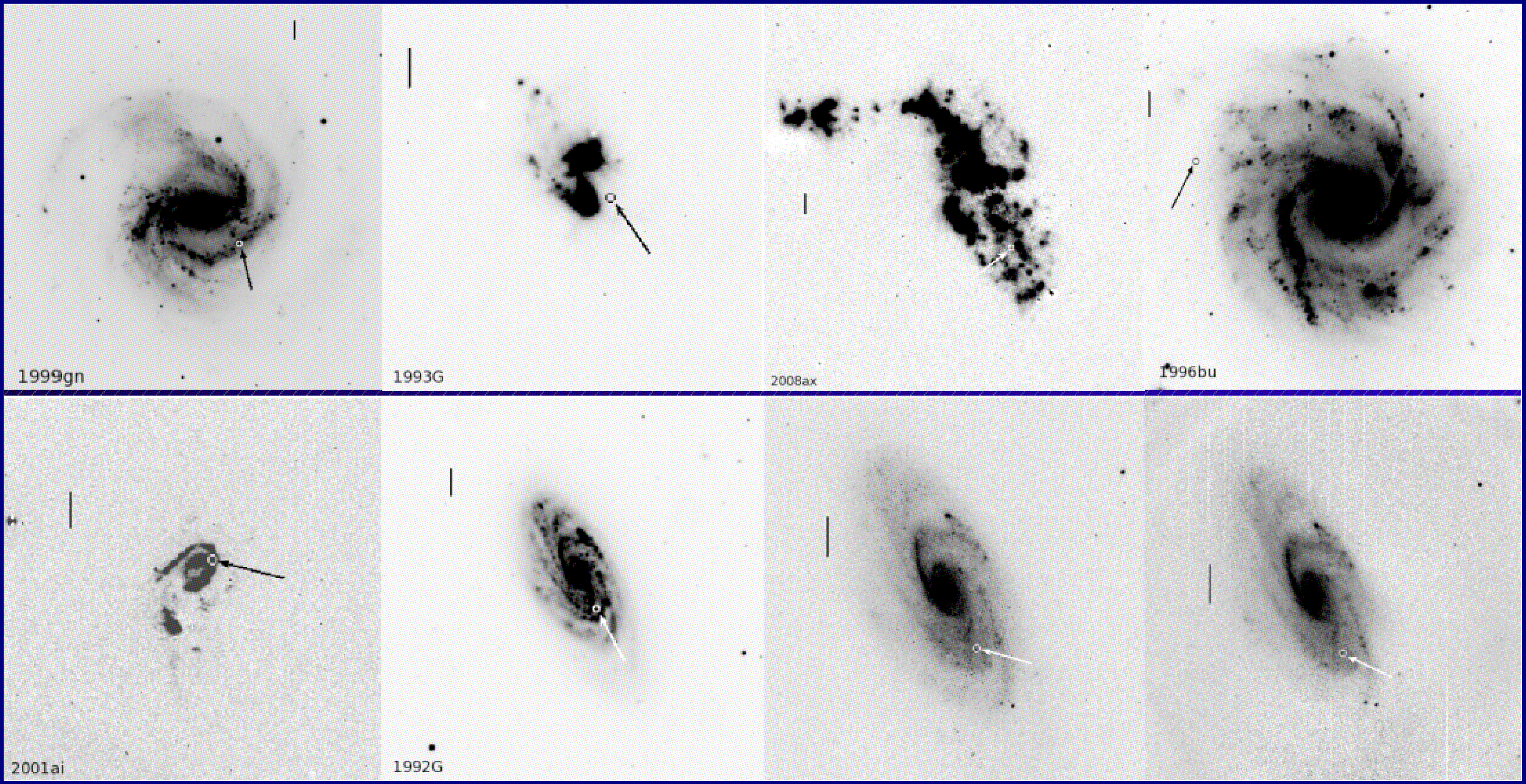

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CONSTRAINING SUPERNOVA PROGENITOR PROPERTIES FROM PARENT STELLAR POPULATIONS

- Characteristics of stellar populations close to historical SNe for progenitor constraints
  - more direct information than the 'whole galaxy' approach
  - statistically significant samples can be studied
- Different stellar age/mass, metallicity etc, stars favour different environments within galaxies

- Hα and *R*-band imaging obtained for a large sample of host galaxies
  - 142 SNII (47 IIP, 10 IIL, 10 IIb, 24 IIn)
  - 83 SNIb/c (32 Ib, 43 Ic)
  - 92 SNIa (43 with m15 values)
  - 7 SN 'impostors'
- Data obtained with JKT, INT, LT, ESO 2.2m

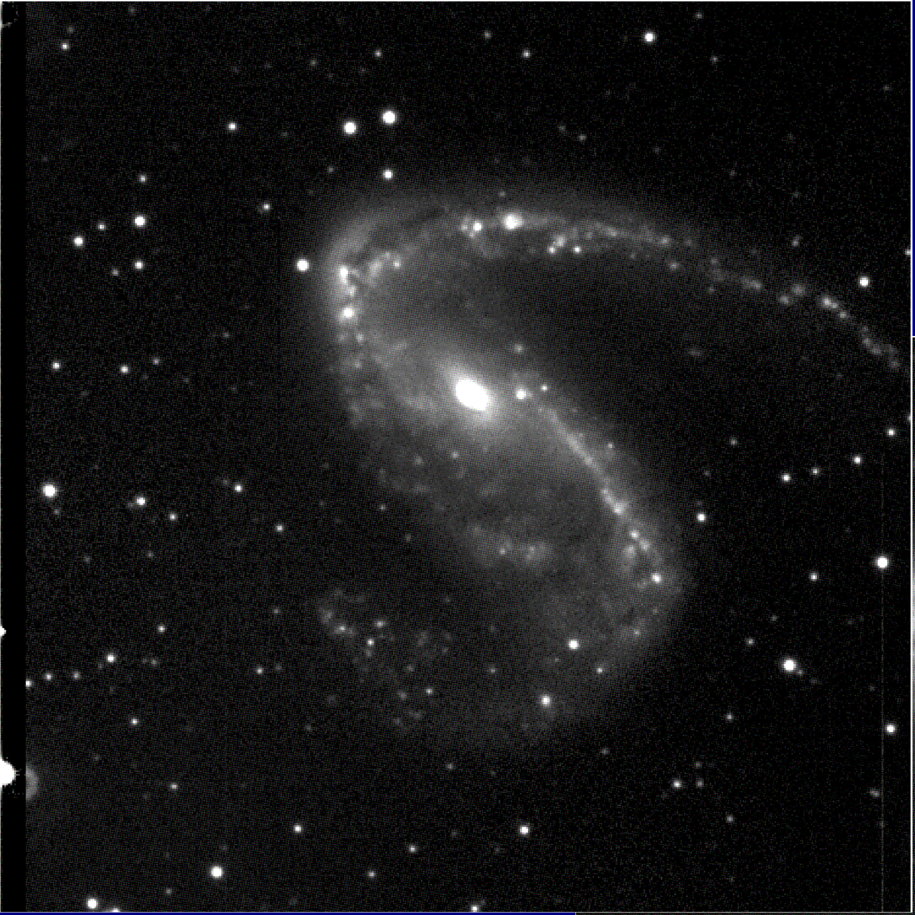
HOST GALAXY H-ALPHA PIXEL STATISTICS

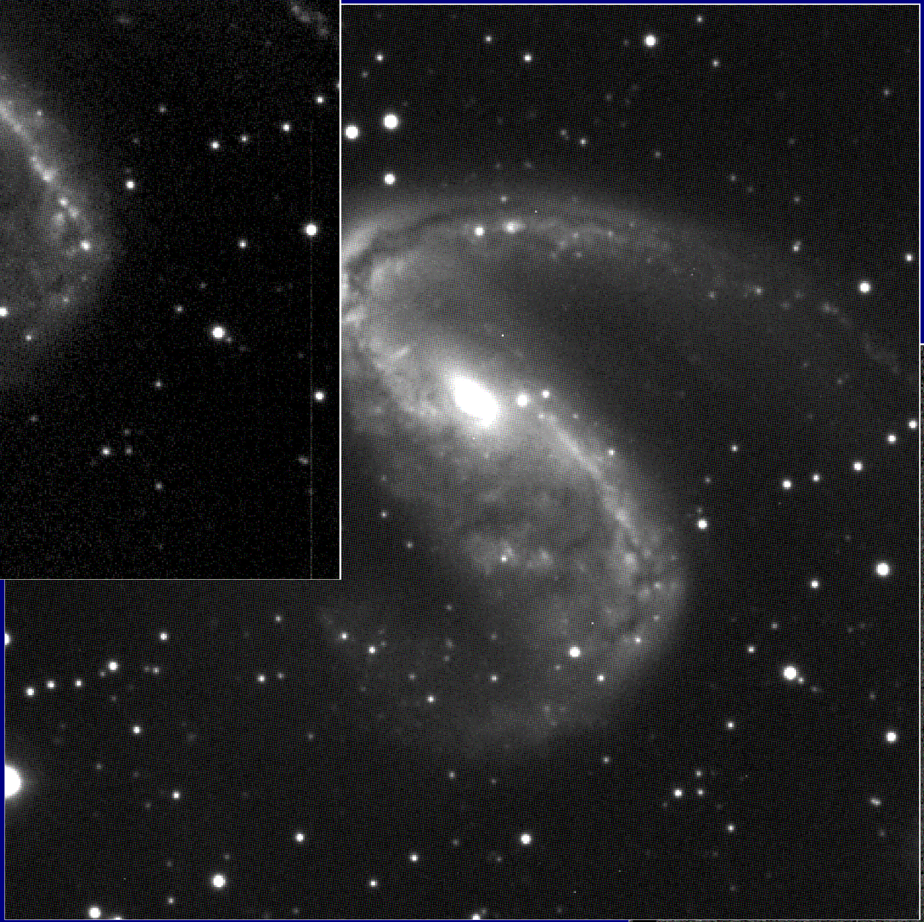
- Pixel statistic produced that gives the degree of association of a distribution to young population
  - James & Anderson (2006)
  - Also see Fruchter et al. (2006)
  - Technique used by Kelly et al. (2008), Raskin et al. (2008, 2009), and Leloudas et al. (2010)

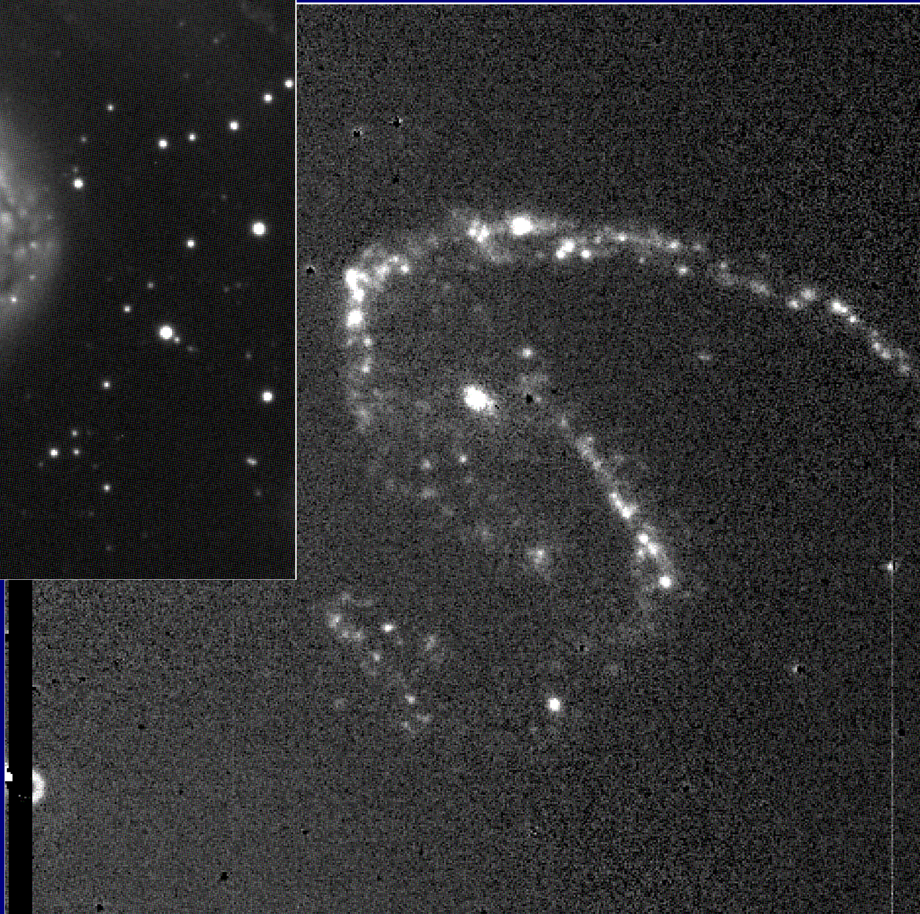
- 'NCR' statistic gives value between 0 and 1 for each SN
  - value of zero indicates zero Hα emission
  - value of 1 indicates the brightest emission of host
- If a progenitor population follows emission then expect a mean value of 0.5 and a flat distribution

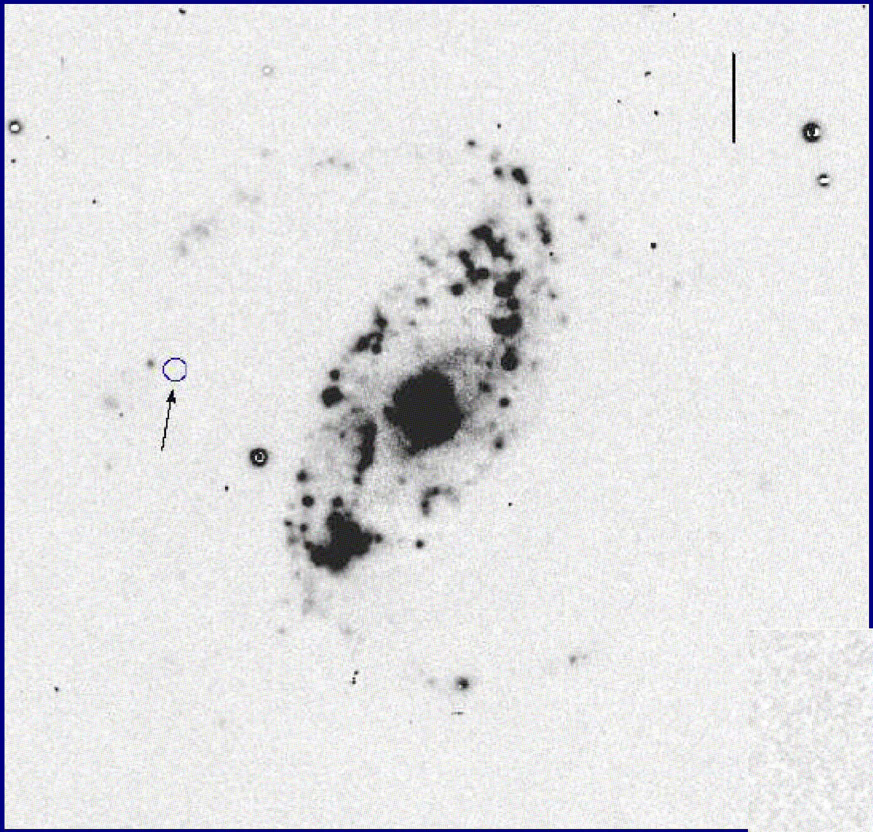
- Initial results presented in Anderson & James (2008)

NGC 2442

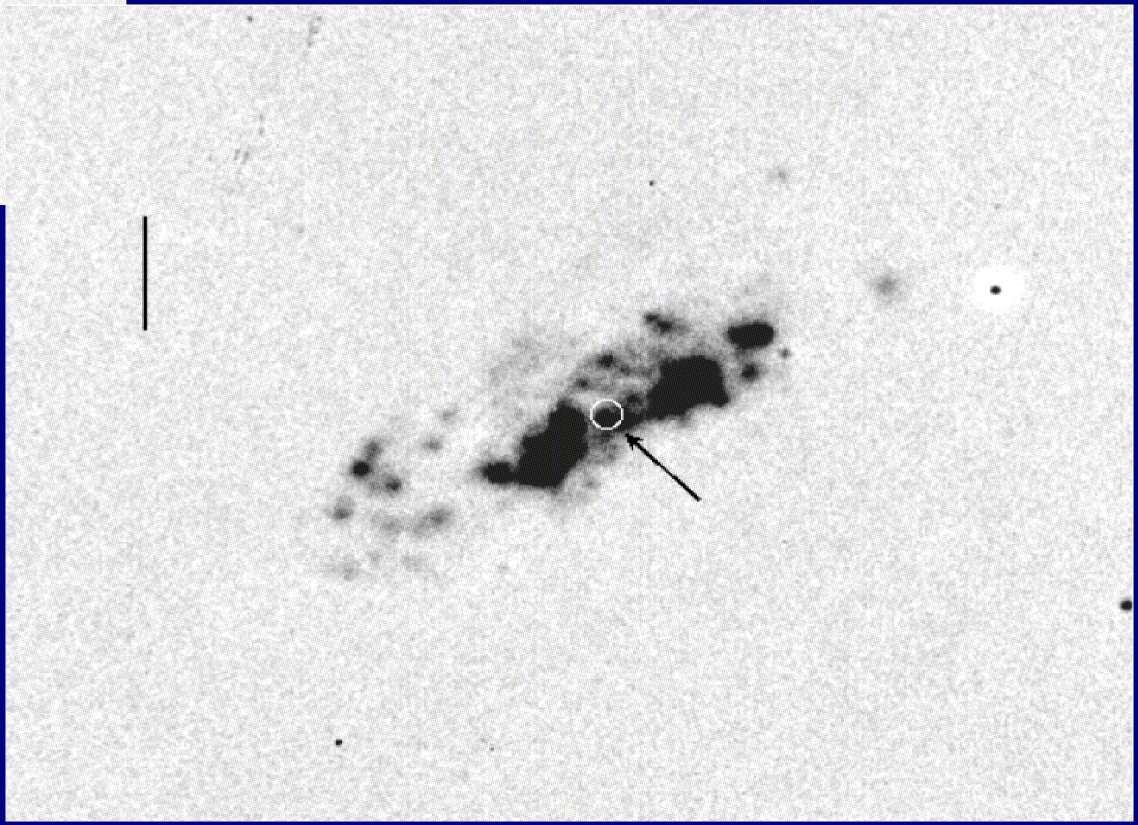




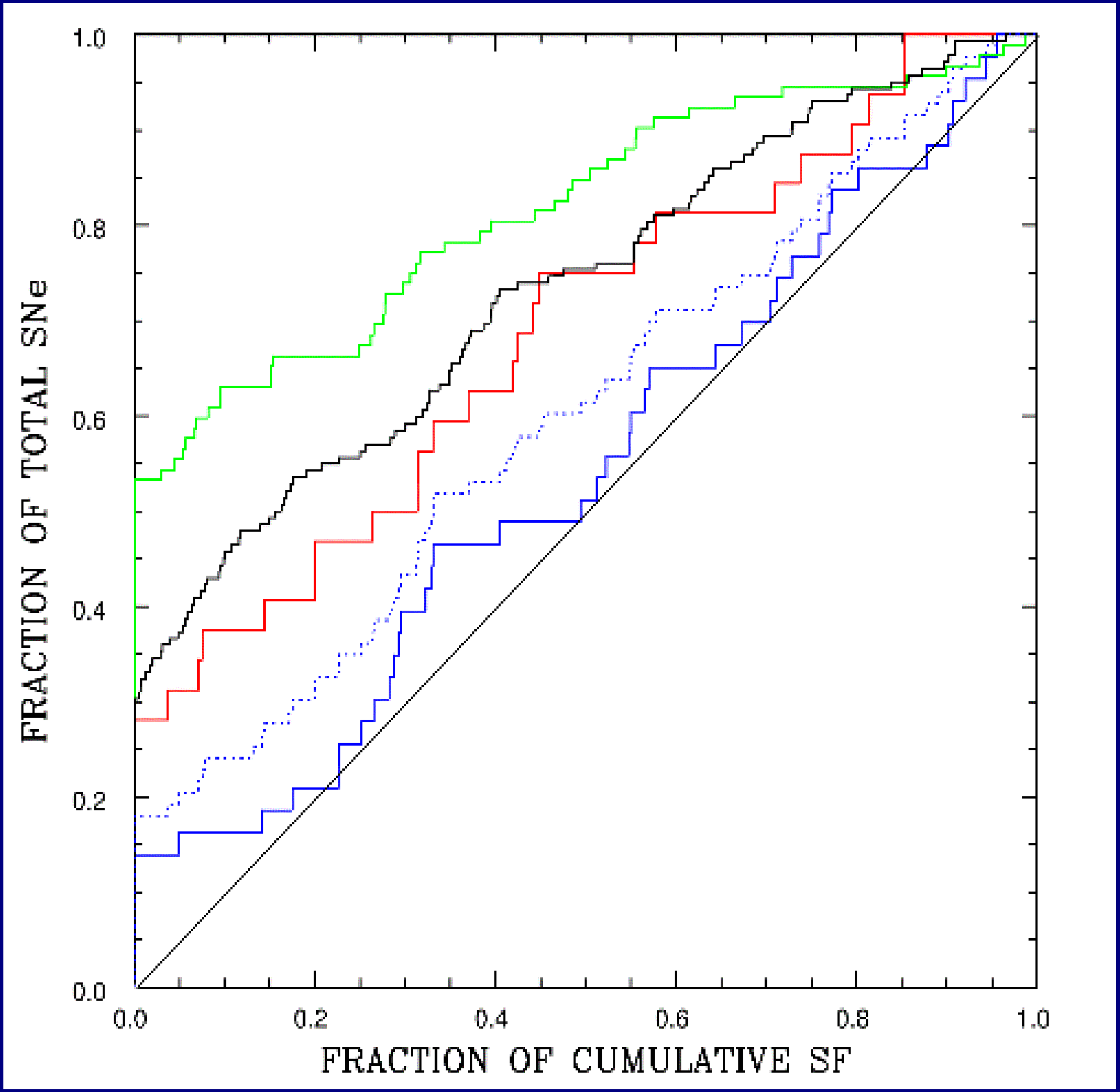




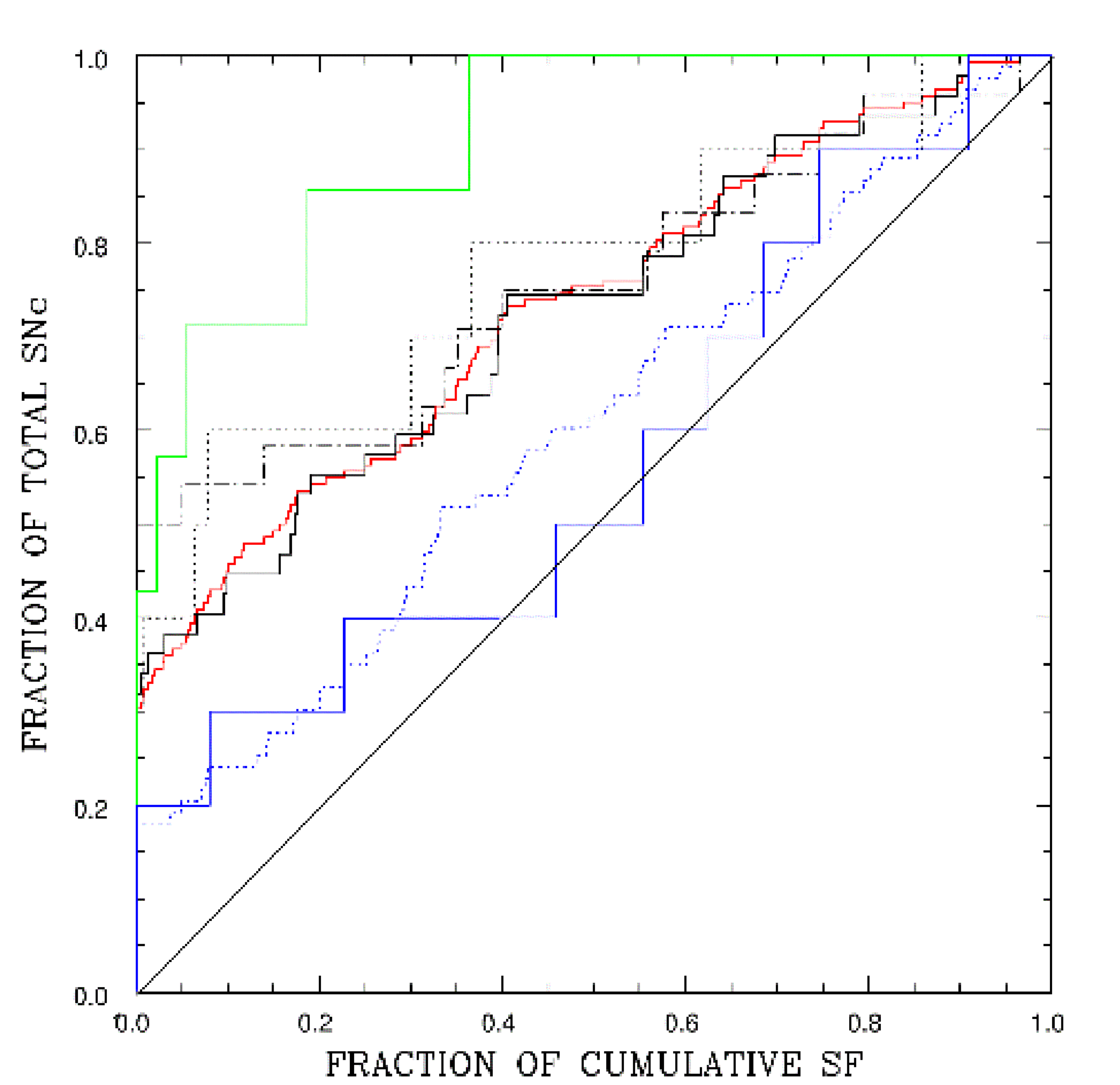
SN 'impostor' 2001ac,
NGC 3504
NCR=0.000



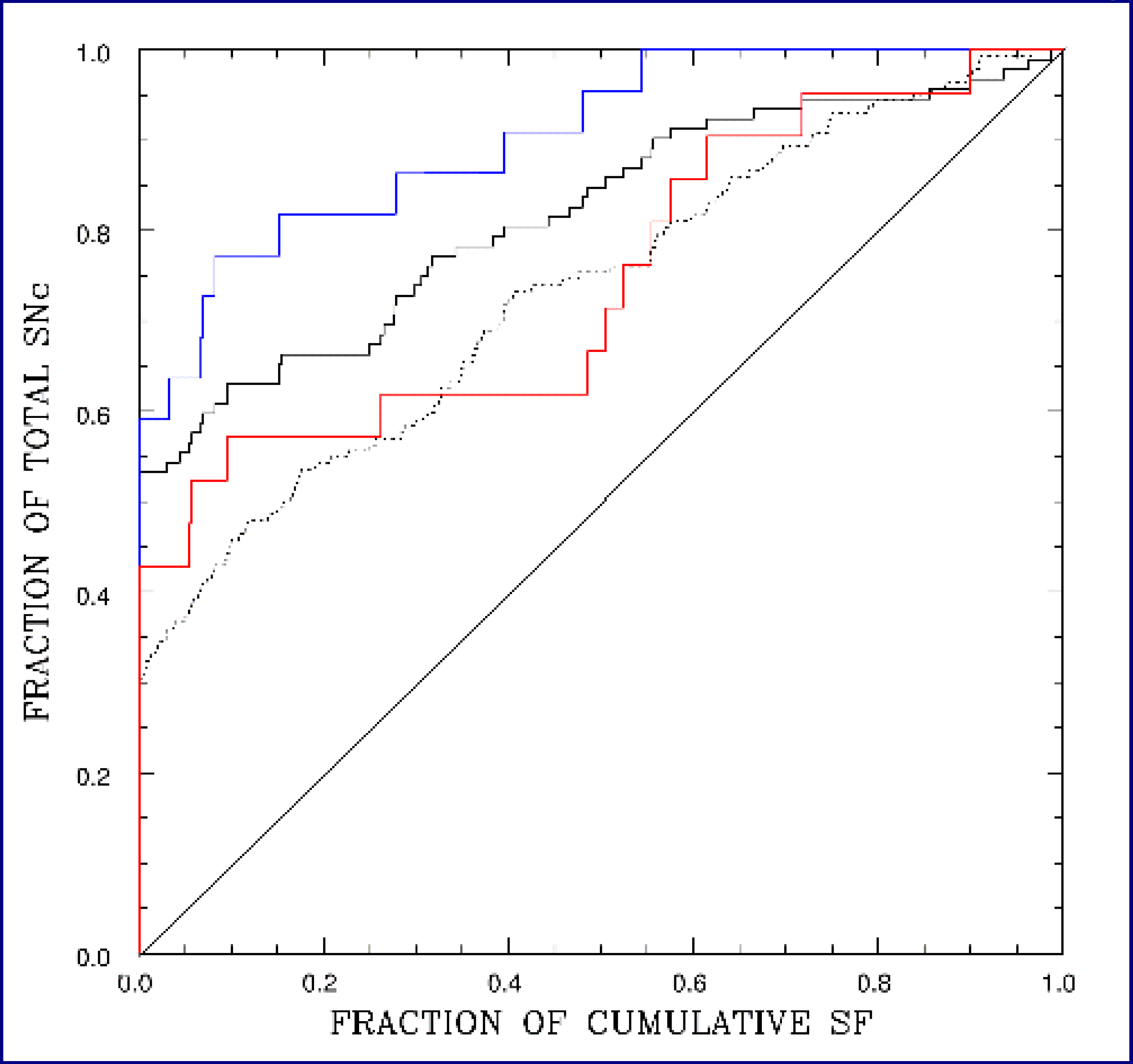
SN Ic 2004bm,
NGC 3437
NCR=0.704



SNIa: green
SNII: black
SNIb: red
SNIc:blue
SNIbc: dotted blue



'impostors': green
SNII: red
SNIIP: black
SNIIL: dotted black
SNIIn: dot-dashed
SNIIb: blue
SNIbc: dotted blue



SNIa: black
SNII: dotted black
Luminous: red
Dimmer: blue

IMPLICATIONS FOR PROGENITOR MASSES/LIFETIMES

Core-collapse SNe:

- Positions of SNIbc follow emission closer than SNII
  - KS-test value ~0.5%
- Progenitor mass/lifetime sequence observed
  - Ia-II-Ib-Ic; SNIc arise from highest mass stars

- SNII sub-types: IIP, IIL, IIn all show similar associations to recent SF
  - majority of SNIIn arise from similar mass stars to SNIIP
- SNIIb show a higher degree of association implying higher mass/ shorter lifetime progenitors

- SN 'impostors' show a very low degree of association to emission
  - surprising result if these transients are LBV eruptions?

IMPLICATIONS FOR PROGENITOR MASSES/LIFETIMES

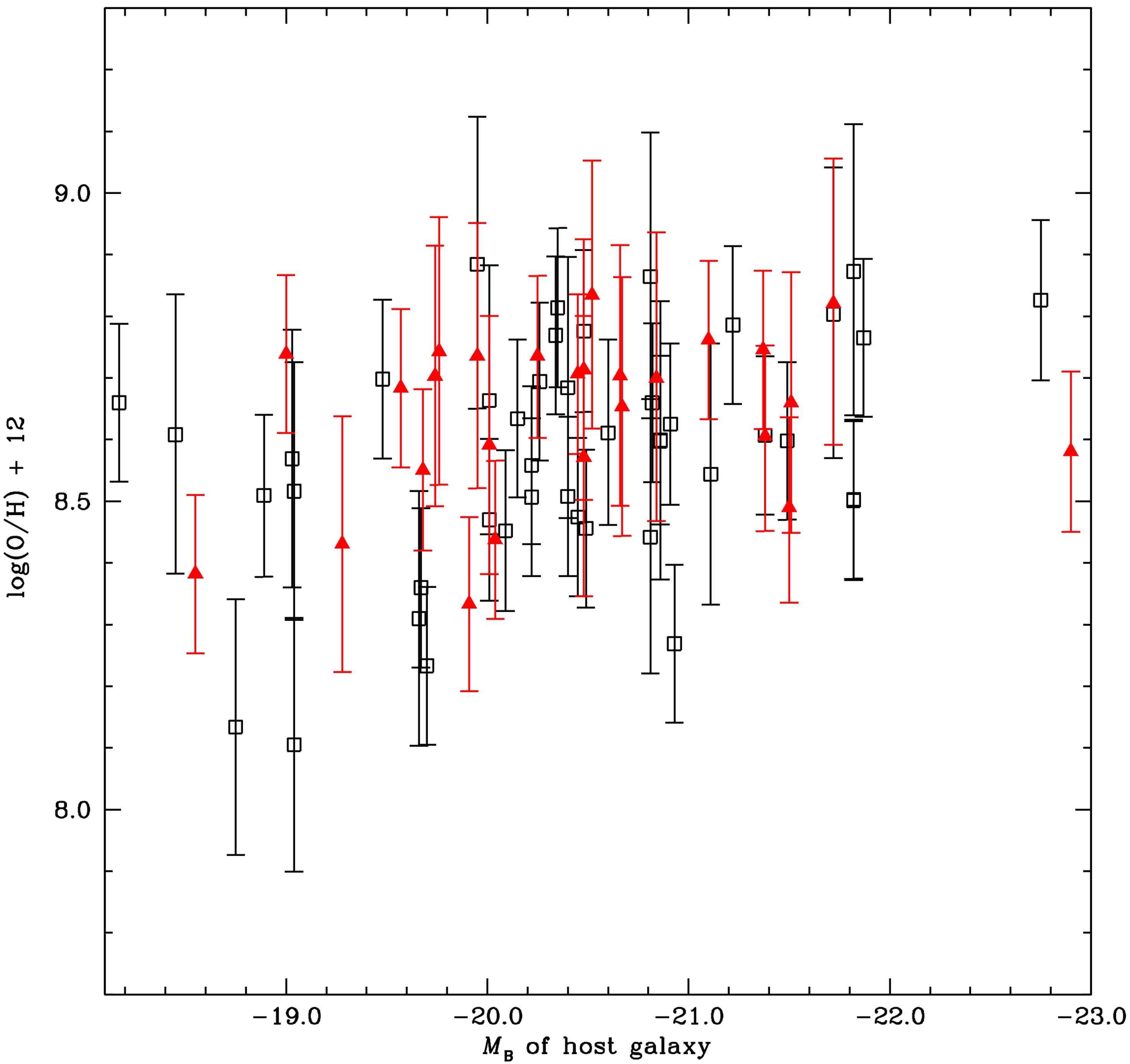
SNIa:

- Overall, as one would expect, SNIa show the lowest degree of association to recent SF
- Split sample into those above and below median Δm15 values
  - overall 43 SNe with Δm15
  - median value 1.06
- More luminous SNe show higher degree of association, implying higher mass/shorter lifetime progenitors
- More luminous events show similar association as type II events

PARENT STELLAR POPULATION METALLICITIES

- Previous constraints have come from indirect methods
  - radial distributions: e.g. Anderson & James (2009), Hakobyan et al. (2009), although see Habergham et al. (2010); next talk
  - Overall galaxy metallicities or those implied from galaxy luminosities: Prieto et al. (2008), Boissier & Prantzos (2009)

- Project follows on from Modjaz et al. (2008), but we include a large number of SNII and SNIbc
- Host HII region spectra obtained for 46 SNII and 27 SNIbc
  - 50 WHT ISIS spectra
  - 23 from thesis of R. Covarrubias
- Measure line ratios close to position of SNe and derive progenitor metallicities using calibrations from Pettini & Pagel (2004)



SNII: black squares

SNIbc: red triangles

IMPLICATIONS FOR PROGNEITOR METALLICITIES

(Anderson et al. 2010)

- SNIbc show slightly higher mean metallicity than SNII, on the Pettini & Pagel (2004) scale:
  - (12+log(O/H)) SNIbc abundance: 8.635 (0.026)
  - SNII: 8.580
  - distributions are marginally consistent with being drawn from same parent population (KS test >10%)
- Both SNII and SNIbc found at all metallicities with no clear transition

- Implies that progenitor metallicity is not a driving parameter in determining SN type from progenitor characteristics

FURTHER INVESTIGATION

- Using statistical techniques to investigate parent stellar populations for SNe occurring in unbiased samples:
  - PTF, Pan-STARRS, etc
  - the requirement of nearby galaxies means waiting for significant samples to be available

- Further investigation into SNIa environments
  - combine current $H\alpha$ data with GALEX, plus near-IR data
  - environment IFU spectroscopy obtained with VLT

- Increase host HII region spectroscopy samples to encompass more diverse number of environments, and also enable SNII sub-type environments to be included

CONCLUSIONS

- Using the nature of the light close to positions of SNe within host galaxies is becoming a powerful tool in investigating progenitor properties

- Using Hα pixel statistics we find that SNIbc more closely follow young stellar populations than SNII, implying younger progenitors
- Progenitor lifetime sequence observed:

  - SNIa – SNII – SNIb – SNIc
- The majority of SNIIn arise from similar mass stars to SNIIP
- SNIIb show a high degree of association to emission, implying shorter lived progenitors than SNIIb
- More luminous SNIa are more often found close to HII regions than dimmer events

- Overall, SNII and SNIbc arise from similar metallicity progenitors